

CLAIMS

We claim:

- 1 1. A process for treating a wastewater stream, including removing substantially all
2 fluoride ions contained in the wastewater stream, comprising:
 - 3 a. exchanging cations in the wastewater stream with hydrogen ions by
4 passing the wastewater stream through a strong acid cation resin;
 - 5 b. removing hexafluorosilicates from the wastewater stream by passing the
6 wastewater stream through a strong base anion resin in sulfate form;
 - 7 c. removing acids from the wastewater stream by passing the wastewater
8 stream through a weak base anion resin, having tertiary amine groups in
9 free base form;
 - 10 d. removing hydrofluoric acid from the wastewater stream by passing the
11 wastewater stream through a weak base anion resin in free base form.
- 1 2. The process of claim 1 wherein the acids other than hydrofluoric acid are selected
2 from the group consisting of HNO_3 , HOAc , HCl , and H_2SO_4 .
- 1 3. The process of claim 1 wherein the strong acid cation resin contains sulfonic acid
2 moieties.
- 1 4. The process of claim 1 further comprising monitoring the wastewater stream
2 passing through the strong acid cation resin to test for ammonium ion
3 breakthrough.
- 1 5. The process of claim 4 wherein said monitoring comprises monitoring the
2 differential pH of the wastewater stream entering and exiting the resin.
- 1 6. The process of claim 1 further comprising regenerating the strong acid cation resin
2 by passing through the strong acid cation resin, at least one of sulfuric acid or
3 hydrochloric acid.

- 1 7. The process of claim 1 wherein the strong base anion resin contains quaternary
2 amine groups.
- 1 8. The process of claim 1 wherein part b further comprises monitoring the
2 wastewater stream passing through the strong base anion resin to test for silica
3 breakthrough.
- 1 9. The process of claim 1 wherein part b further comprises regenerating the strong
2 base anion resin by passing through the strong base anion resin, hydrochloric acid
3 followed by sulfuric acid.
- 1 10. The process of claim 1 wherein part c further comprises monitoring the
2 wastewater stream passing through the strong base anion resin to test for chloride
3 breakthrough.
- 1 11. The process of claim 1 wherein parts c and d further comprise regenerating the
2 weak base anion resin having tertiary amine groups in free base form with a
3 sodium hydroxide solution.
- 1 12. The process of claim 1 wherein part d further comprises monitoring the
2 wastewater stream passing through the weak base anion resin to test for electrical
3 resistance.
- 1 13. The process of claim 1 further comprising monitoring the wastewater stream
2 passing through the strong base anion resin to test for fluoride breakthrough.
- 1 14. The process of claim 1 further comprising regenerating the weak base anion resin
2 by passing hydrochloric acid through the weak base anion resin.
- 1 15. The process of claim 1 further comprising adding to the removed hydrofluoric
2 acid, at least one of $\text{Ca}(\text{OH})_2$ at a concentration below solubility limits or CaCl_2 .

- 1 16. A process for treating a wastewater stream including removing substantially all
2 fluoride ions contained in the waste water stream, comprising:
- 3 a. exchanging hydrogen ions in a strong acid cation resin containing
4 hydrogen ions with aluminum ions by passing a solution of aluminum salt
5 through the strong acid cation resin;
- 6 b. rinsing the strong acid cation resin with water;
- 7 c. removing hydrofluoric acid from the wastewater stream by passing the
8 wastewater stream through the aluminum ion exchanged strong acid cation
9 resin.
- 1 17. The process of claim 16 wherein the aluminum salt is at least one of aluminum
2 chloride or aluminum sulfate and the corresponding acids are hydrogen chloride
3 or hydrogen sulfate respectively.
- 1 18. The process of claim 16 further comprising collecting the total runoff from said
2 exchanging and rinsing in a tank.
- 1 19. The process of claim 16 further comprising adding the mixture of mineral acid
2 and total runoff from said exchanging and rinsing to the strong acid cation resin.
- 1 20. The process of claim 16 further comprising monitoring the wastewater stream
2 passing through the strong acid anion resin to test for fluoride breakthrough.
- 1 21. The process of claim 16 further comprising regenerating the strong acid cation
2 resin by passing through the strong acid cation resin, a concentrated mineral acid
3 corresponding to the aluminum salt passed through the strong acid cation resin.